Effect of Activity Based Method on Science Process Skills, Academic achievement and Attitude of Secondary level students

A
REVISED SYNOPSIS
Submitted to
Dayalbagh Educational Institute
(Deemed University)
For the Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
[2017]

Supervisor

Prof: Savita Srivastava

Researcher

Sadhana

Prof. K.C. Vashishtha

Head & Dean

Dept. of Foundations of Education,

Faculty of Education

FACULTY OF EDUCATION

DAYALBAGH EDUCATIONAL INSTITUTE

(DEEMED UNIVERSITY), DAYALBAGH,

AGRA

1.0.0 INTRODUCTION

The progress, welfare and security of a nation depend on a rapid planned and sustained growth in the quality and extent of education and research in science. Science is universal and so can be its benefits. We are in a crucial stage in the progress of development and transformation. In this context, the role of Science is of utmost importance. Science education being an important component of the education system should contribute to the solution of the problems of the country by developing desirable understanding of skills, attitudes and values. "Science in fact is more than a subject: it is a method of acquiring knowledge" (Griggs, 1990). The term "Science" (Scientia) is etymologically synonymous with knowledge, which of course does not imply that all knowledge is Science. In the literal sense, science means the pursuit of knowledge, but it has a wider connotation for our purpose and can be said to mean knowledge of nature in the widest possible form. This is an age where all the modern society is completely drawn in to the scientific environment and Science has become an integral part of our life. Thus knowledge in Science is necessary to lead a successful life and also to cope up with numerous problems in life. Report of the Education Commission (1964-66) has remarked "There is of course one thing about which we feel no doubt or hesitation: education, Science based and in coherence with Indian culture and values can alone provide the foundation and also the instrument for nation's progress, security and welfare."

Definition of science: According to Fitzpatrick (1960) "Science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it.'' According the Schlesinger (2000) "Science is a process of the human intellect. It is a way of thinking, a way of doing, a method of discovering new relationships in the physical and biological universe." These definitions emphasize three basic principles of the nature of Science. Science is an accumulated and systematized body of knowledge, the scientific method of enquiry and the scientific attitude. The first point indicates the product of Science, while the second and third point indicates the process of Science. In other words, Science is both a product and process. Products are the outcome of process. Systematic observations and experimentation leads to the formulation of theories and generalisations. The science process skills

such as observation, classification, communication, measurement, prediction and inference and so on can be translated into immediate behaviour by the child as he attempts to understand the phenomena of science encountered in his environment. Pupil should observe measure, classify, use numbers, see relationship, make hypothesis, devise experiments, interpret evidence, draw conclusions and verify the findings. It refers that, systematic way of knowing science. As part of the study of science, pupils have to develop the capacity to deal with the problems in his day to day life. It can be achieved only through his constant involvement with the process of science. Therefore a process oriented approach to science teaching and learning can serve the causes of science education. Science process skills enable student how to think scientifically by applying problem solving techniques to science lessons, while all lessons should incorporate process skills in discovering science concepts, teaching science process skills in primary grades will specifically help students retain science lessons longer. Using creative ideas to teach science processes like observing, classifying, predicting and inferring will help the students discover scientific concepts. The effectiveness of Science education to a very large extent depends upon the method of teaching and learning of Science. There is a growing realization among our curriculum planners, academics and educational administrators that our Science educations at school level fail to fulfill its objectives. The new curriculum, as part of modernization of education system has made use of modern Psychological theories also. The most important among such theories are constructivism and enquiry learning, theory of multiple intelligences etc. The National Curriculum Framework (NCERT, 2000) shares their concern in the poor quality of Science education in India. They also envisage a process oriented approach in the teaching of Science, Science teaching as process ensures the active involvement and participation of the learner through appropriate learning activity. This makes way for sense learning and consequently enhanced perceptual clarity and conceptual clarity.

1.1.0 Nature of Science

Science as an enterprise has individual, social, and institutional dimension. It is fundamentally a means of understanding why things happen as they do. Man has found science as a process by which his search for answers to his unlimited questions can be approached systematically. In this way the

study of science is an intellectual and social endeavour — the application of human intelligence in figuring out how the world works, should have a prominent place in any curriculum that has science literacy as one of its aims. Bullock (1976), a historian has deemed science to be 'the greatest intellectual and cultural achievement of modern man'. He perceived science as an open-ended process in which imagination, hypotheses, criticism and controversy take a dominant role. It is not, nor was it ever, 'the closed dogmatic system of immutable laws. Bullock sees science as a humane activity, deeply concerned with man and society, providing scope for imagination and compassion as well as for observation and analysis. Conant (1951), an eminent scientist and an educator also defined science as "an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful to further experimentation and observation". Science thus, is simultaneously a body of knowledge and a way of gaining and using that knowledge. The accumulated and systematized body of knowledge, which is the 'product' of science— has a dynamic counterpart, the scientific attitudes and methods of inquiry-which is the 'process' of science. Science thus is a combination of both 'processes' and "products' related to and dependent upon each other. When, used in this way, science offers methods of inquiry useful in learning more about the universe and its workings. The interrelation and expanding nature of the processes and products of science is shown in the following figure Inter-relationship between scientific processes and products.

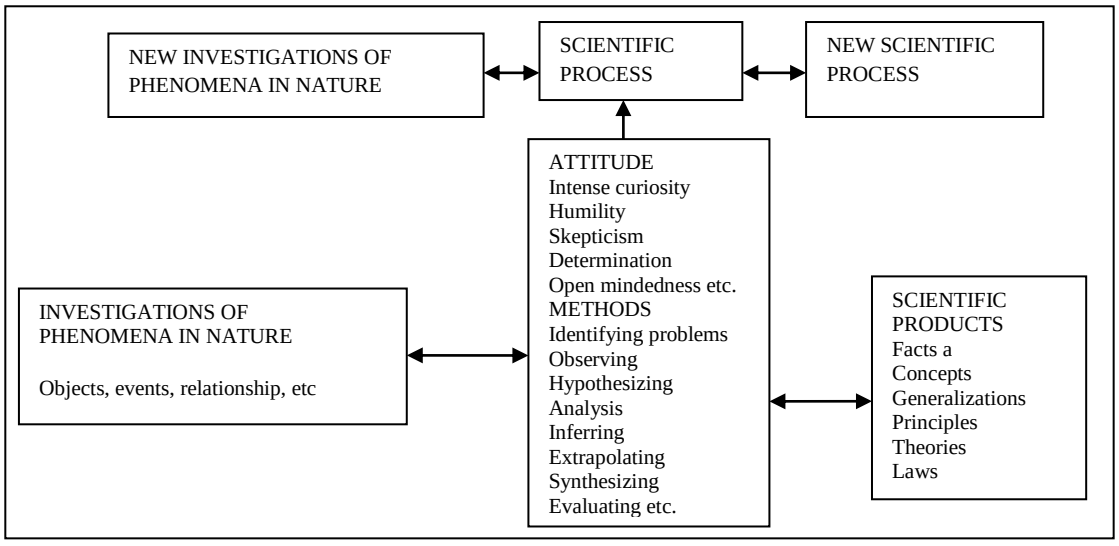

Fig. 1.1: Inter-relationship between scientific processes and products (Carin & Sund, 1964)

The processes of science include scientific attitudes and methods of inquiry. Scientific attitudes include both emotional attitudes such as curiosity, humility, determination, open mindedness and intellectual attitudes namely objectivity, skepticism and rationality. The methods of inquiry are observing, hypothesizing, analyzing, inferring, extrapolating, reasoning and synthesizing etc. The scientific attitudes develop simultaneously with science process skill development and with the discovery or construction of useful science ideas. The information and ideas of science that compose its knowledge base are often referred to as `products' since new discoveries add to the base of scientific information which are the products of curiosity and experimentation. An interesting thing about science knowledge is that new discoveries often lead to more questions, more experiments, and further discoveries. The science cycle move under its own momentum propelled initially and again later sustained by human curiosity and a desire to explain natural phenomena. The effect is an exploding accumulation of new information that is added to the knowledge base. Scientific knowledge consists of primarily facts, concepts, principles and theories. The scientific theories are refined in the light of new ideas which Kuhn (1970) called a new paradigm.

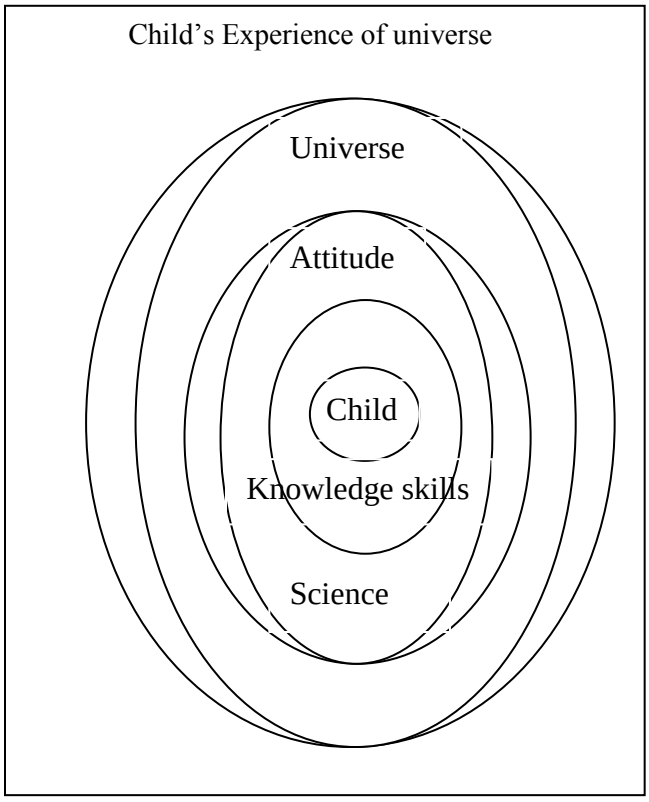

Fig: 1.2: The Science Cycle

It is a well-known fact that children are curious. Their curiosity motivates them to discover new ways to use this powerful key for unlocking the mysteries of their world. As said earlier, both the products and processes for acquiring them are to be experienced by the students. Children receive a whole science experience when they are immersed in all the three parts of science. The synergy among the parts which makes science whole is shown in the Science cycle given in fig. 1.2. Attitudes are mental predispositions towards people, objects, and events and so on. In science, attitudes are important because of three primary factors. First, a child's attitude carries mental state of readiness with it. With a positive attitude the child will perceive science objects, topics, activities and people positively. Secondly, attitudes are not innate or inborn. They are learned and organized through experiences as children develop. Thirdly, attitudes are dynamic result of experiences that act as directive factors when a child enters into new experiences. As a result, attitudes carry an emotional as well as an intellectual tone. Attitudes not only improve achievement, but also build up interest and self esteem which is represented in the following diagram.

Importance of Basic Science Attitudes (New York: Mc Graw-Hill, 1979)

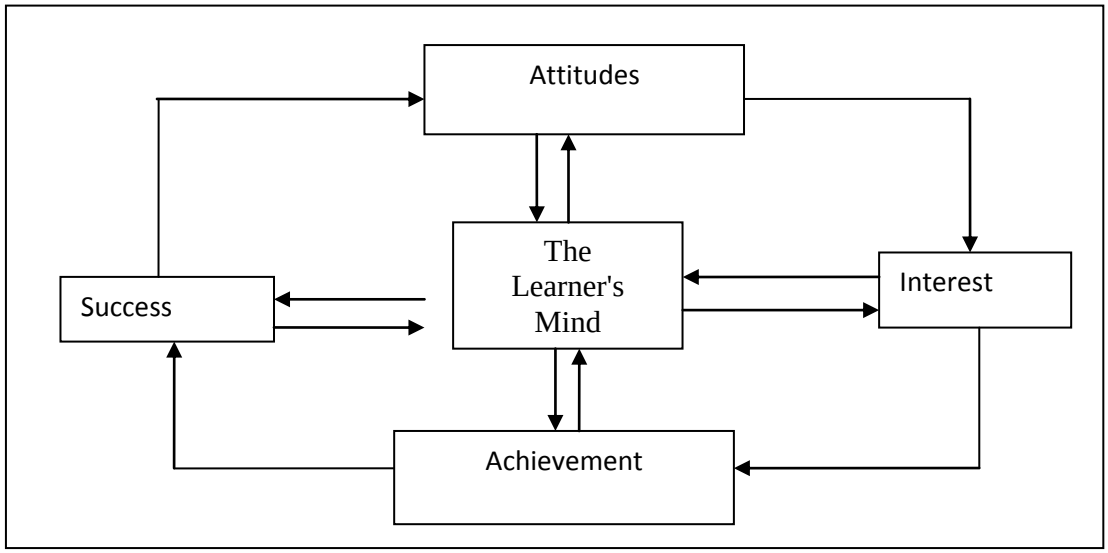

Fig. 1.3: Importance of Basic Science Attitudes (Source: Adapted from Benjamin Bloom, Human characteristics and school learning)

Attitude towards science, according to Duckworth (1975) refers to the "disposition of mind for or against scientists, scientific activity and learning of science" and has predominantly affective

Orientation. On the other hand, scientific attitude is "the cognitive attitude or belief about thinking and has also affective and behavioural aspects" (Guilford, 1978). A part from the knowledge and attitudes, there is one more part of science i.e. science process skills. Children learn how to learn by thinking critically and using information creatively. They continue to learn how to learn when making discriminating observations, when organizing and analysing facts and concepts, when giving reasons for expected outcomes, when evaluating and interpreting the results of experiments. When drawing justifiable conclusions (Victor, 1971). In science, the ways of thinking, measuring, solving problems and using thoughts are called processes. Process skills describe the type of thinking and reasoning required.

1.1.1 Science as a Product

Concepts are always tentative; all propositions are subject to being revised or falsifiable. Hurd (1971) opined that significance of concepts and facts are constantly shifting within the scientific discipline and new ideas and theories leads to change present knowledge. NCF (2005) suggested content validity is one of the basic criteria for science curriculum and it demands that science curriculum must convey significant and scientifically correct content. The content presented in the curriculum is not just for memorisation, it is for comprehension. Students should not come out of science class with a memorised set of definitions without understanding the contents. Students must know the reason behind the concepts for example why warm air rises up, what is essential to support combustion, how sound travels in a medium. Practical learning should be promoted and rote learning should be discouraged. Such learning becomes more permanent, meaningful and concrete. The purpose of learning science at early stage is not behave like scientist, rather the purpose is to develop process skills, concepts and attitudes towards science which will enable them to cope up effectively for their further education and achievement.

1.1.2 Science as a process:

The process of doing ‘Science’ is the science process skills that scientists use in the process of doing science. The Science Process Skills forms them foundations for scientific method. Science is both thought and action. Thought is nothing but the ideas, conception, and beliefs about the natural phenomena on wherein the action is methods and the process includes certain set of skills and abilities

such as observation, measurement, communication, testing hypothesis, design experiment, changing variable etc. These skills are commonly called scientific method. These skills are the foundation for formulation of theories, generalisation, principle, and laws. It encourages the spirit of inquiry through laboratory experiments. Menon (1986) stated that the processes of scientific inquiry represent the spirit of science as an activity and its essence that it distinguishes science from other discipline. Hands-on minds-on experiments and activities provide rich learning experiences for the students to acquire science process skills. These are chiefly mental skills, but also associated with physical skills.

1.2.0 Concept and Genesis of Science Process Skills

Science process skills are commonly used the term now, but one point of time synonymously it was termed as scientific method, scientific thinking, and critical thinking and processes of science. Harlen (1992) stated that process skills include planning, following directions, observing, experimenting, measuring, predicting and inferring; these are concerned with processing evidence and ideas, and so are often called process skills. Science process skills are the set of procedures which are employed by scientist during investigation and discoveries. SAPA (Science: A Process Approach) describes that scientific process skills are defined as transferable skills that are applicable to many sciences that reflect the behaviour of scientists. By observing the above definitions it can be inferred that science process skills are the set of intellectual skills which are performed by our mind in association with sensory organs during the process of science. Early to 1960 there was a proliferation of new science programmes. This was a manifestation of a shift in emphasis of teaching from content to process skills. The process of science first implied by the American Association for the Advancement of Science in their programme (AAAS) called Science: A Process Approach (SAPA), after 1960 "Content" was de-emphasised.

Following curriculum change projects were launched and renovated to emphasis processes of science in science teaching namely Physical Science Study Curriculum (PSSC), Science A Process Approach (SAPA), Harvard Physics Project (HPP), Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS), Elementary School Science Curriculum Improvement Study (ESSP), School Science Curriculum Project (SSCP), Minnesota Mathematics and Science Teaching Project (MINNEMAST), Conceptually Oriented Programme in Elementary Science (COPES), Chemical

Education Material Study (CHEMSTUDY), Chemical Bond Approach (CBA), Science in Process, Warwick Process Science (WPS), Nuffield courses in the UK (Figure 1.3).

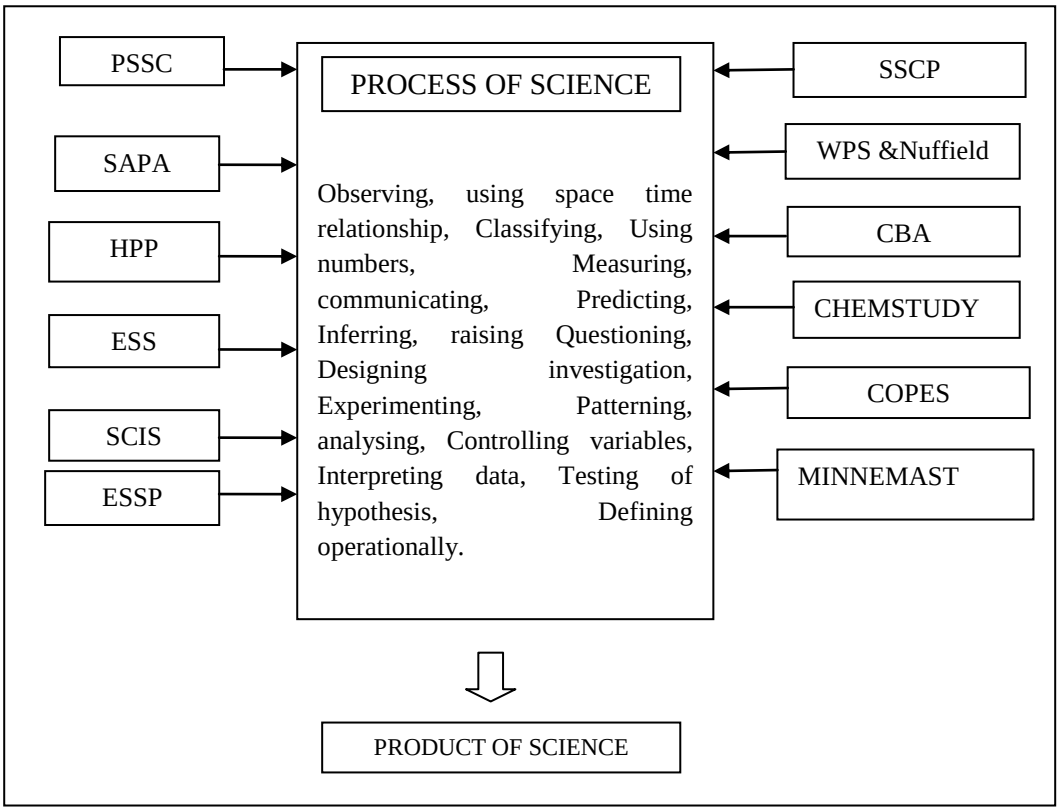

Fig.1.4: Curriculum Projects

These curriculum reforms and projects stresses on process skills through different approaches such as inquiry approach, investigatory approach, and discovery approach of teaching science. All the Curriculum reforms and projects findings reveals that the process approach is more effective in increasing pupils' science achievement and attitude compared to traditional science program. By realising the need and importance of science process skills, Current Science Education Standards such as Science for All Americans (SAA, 1990), the Benchmarks for Scientific Literacy (1993), National Research Council (NRC, 1996), and National Science Teachers Association (NSTA, 2002) advocated the Science Process Skills among the school students. By considering the importance of process aspects of science, much earlier Secondary Education Commission (1952) recommended that science curriculum should provide opportunity to carry on practical activities and laboratory work. Subsequently, all commissions and policies continuously emphasises development of process skills. At present, there is a shift in the Science curriculum to emphasise from content of science to process

of science. It was stated in the NCF (2005) that development of process skills up to standard X is one of the objectives of teaching of science.

1.3.0 Classification of Science Process Skills

The American Association for the Advancement of Science (AAAS), UNESCO (1992) identified thirteen process skills under two major classification namely Basic and integrated. Basic Science Process Skills (BSPS) are Observing, Classifying, Communicating, Measuring, Predicting and Inferring. These basic process skills are foundation for acquiring the integrated process skills. Integrated Science Process Skills (ISPS) are identifying and defining variables, describing the relationship between variables, formulating and testing hypothesis, collection of data, designing investigation and experimentation, manipulating the variables, identifying the cause and effects, acquiring organising and displaying the data with charts, graphs, tables. All these process skills are interrelated; there is no sequence or particular order of these skills. Any skill can begins first, all other skills follows later. But most of the time observation skill starts first, rest of the skills follows later

1.3.1 Basic Science Process Skills (BSPS)

(a) Observation

Observation is the fundamental science process skill among all other process skills. The process of observing is taking in information through sense perceptions. It is the most basic and broadest skill through which all other skills are refine it. Good observations lead to the development of other science process skills such as communicating, predicting, measuring, classifying and inferring. Observation begins from every activity of science. It is more than just 'seeing' and it is associated with collecting data using all the senses such as eyes, nose, ears, tongue and skin as well as instruments that extend beyond the reach of our senses. Seeing allows the students to notice such properties as sizes, shapes, colour of objects or organisms, it is also to gather fine details. Hearing makes knowable properties of sounds such as loudness pitch and rhythm. Touching is to know the texture hardness roughness softness powdered crystalline in nature hotness and coldness. Tasting is to feel how some properties of substances are bitter sweet sour and salty. Smelling is to recognise the odour of particular chemical substances, and food items based on the commonalities and differences. There are two aspects in development of the observation skill: attention to detail and ability to distinguish what is relevant to a

particular investigation. UNESCO (1992) said that what children say, draw or write about what they see smell hear or taste or feel with their fingers is an important source of evidence of their observation. During observation one can use hand lens and microscope for observing the minute detail about the particular events or occurrences. Observation should be till the end of event or completion of experiments not just only in the beginning. Deep observation can provide more accurate information. The observation can be classified both qualitative and quantitative. Qualitative observations are qualitative in nature that is descriptive terms such as colour, smell, texture, properties and characteristics' of object or things or organisms. Quantitative observation refers to notice the numbers in terms of object or things or organisms. Quantitative observations usually are more precise than qualitative observations. For example: observing the number of legs in centipede millipede or number of segments in earthworm or number of tentacles or antenna in some insects or if a student reports that a lemon has six seeds it is likely that other children observing the same piece of fruit would make the same quantitative observations. Observations using comparisons such as "an arm's length" or "as big as my fist" are considered quantitative. Classification is the process of sorting, grouping, ordering or arranging objects on the basis of similarities and differences, larger or smaller and other common characteristics. Most intuitive thinkers can select and group the objects by some common property such as colour shape and size. The classification can be qualitative as well as quantitative. Qualitative classification based on size shape colour habit and habitat and the nature of substances such as smoothness roughness hardness softness opaqueness transparent solids liquids gases etc. Quantitative classification is based on number for example: age, number of leaf or petals in a flower. The classification can be binary or multistage. In binary classification system a set of objects or things are classified into two subsets for example (i) living being is classified into plants and animals (ii) animals are classified into vertebrates and invertebrates. Binary classification is the most basic form of classification. In multi-stage classification each subsets follows consecutive binary classification or succession of binary classification for example, subset animals further classified into mammals birds lizards reptiles and so on. Classifications of things or objects or substances are not only unidirectional, it can be multidirectional also i.e. grouping or arranging them into more than one category based on presence and absence of certain attributes. For example: a group of living

organisms are classified into birds' reptiles' insects unicellular multicellular herbivores carnivores omnivores terrestrial and aquatic animals vertebrates and invertebrates mammals etc. Objects, things, substances and organisms can be classified in different ways but before going for classification one has to think whether the particular property is being present or not. Thorough observation is needed before arranging or ordering the things. Classification skill helps to understand and conceptualise the scientific ideas in a systematic manner. Classification helps the students' to retrieve information from a conceptual scheme. Classification skills develop creativity and also develop divergent thinking. Classification skill helps to relate the objects having similar attributes through which concepts can be constructed.

(b) Communication

Communication skill refers to convey of information from one person to another by verbal or nonverbal means. Verbal communication conveys the information orally using scientific terminologies clearly. Nonverbal forms of communication are through charts, graphs, maps, and drawings, symbols, pie chart, tables, chemical formulas of particular element or compound, symbols of electric component, flow chart. Harlen (1992) argues that both written and oral recording communication are integral parts of the activity because making records helpful for further discussion and display through adequate communication way for easy understanding. Making record is the part of communication which helps for future verification. Observation and communication are two process skills which are absolutely essential for an individual to relate to the physical world. Scientists use to communicate with another person about what they observed or discovered. They makes model, draw able graph or histogram symbols to convey the information. Communication skill helps the learners to reflect on their own learning and to build confidence as a person.

(c) Measurement

Measurement is the act of using numbers to describe objects or events. Measurement is a process wherein measure the attributes that are measurable such as temperature, length, breadth, height, area, mass, and volume. Measurement is a process which involves comparison of an entity with standard measurement. Measurement skill follows calculation, after completion of every measurement it should be written with proper measurement unit for example: Units like centimetre or millimetre

Kilogram length breadth temperature weight mass area volume etc. Prior to measure the objects or liquids one has to choose appropriate measuring instruments such scale, ruler, meter stick, yardstick, balance, clock, thermometer, graduated cylinder or containers, Protractor , screw gauge, vernier calliper, and tape. Also it is very essential to ensure that the selected measurement device is standardised or not, capacity (range), increment values, and calibration or adjustment to ensure the proper use of the instrument, whether the device is numbered or unnumbered, and ensure the accuracy of instrument.

(d) Predictions

Predictions are the statements about what might happen or could be expected to happen in the future. It is based on some relevant prior knowledge in a form which can be investigated. Prediction is the act of predicting the forecasting events based on a previously developed model or experience. A model is a visual or cognitive representation that relates various aspects to one another; a well developed model allows one to be more confident in making predictions related to a situation, for example: Meteorological model that allows forecasters to make accurate predictions of future weather conditions in a locale (Bentley, 2007). Prediction can be based on the use of available evidence or past experiences but there should be proper justification for the prediction (UNESCO, 1992). For example, based on observation of simple pendulum experiment one can predict what would happen if length of the pendulum increased Predictions, unlike inferences, are verifiable. A prediction is not a wild guess; a guess has no rational foundation. Predictions are kinds of thinking that require learners' best guesses based on the information available to them. It involves the learners in using knowledge to decide what will happen if something is changed in a situation. Prediction can develop one's deep thinking and logical analysis and interpretation. Before conducting an experiment or activity one can predict 'what will happen? Later, prediction should be verified. Prediction also can be based on inferences.

(e) Inference

Inference is the act of making statements based on observations. Inference is a process of making suggestion, conclusions, assumptions or explanations about a specific event based on observation. Inference is different from observations, there can be a misconception that observations are inference

but both are different conceptions. Observation is the use of one's senses to perceive objects and events and their properties. Inferences are making Statements or conclusions after a deep observation and understanding of a phenomenon, therefore observations are the base for any inference. For example a student observing a plant and reported that "two leaves are dying". In this, student made inference based on the observations of colour difference of the leaves (two leaves colour is yellow or brown and other leaves are green). Sometimes more than one inference can be made based on a list of observations. Inference skill encourages metacognition process and it stimulates higher order thinking skills, problem solving skills and decision making skills. Inference helps to identify the Cause and effect relationship.

1.3.2 Integrated Science Process Skills (ISPS)

Formulation of Hypothesis: Formulating the Tentative statements or expected outcome for experiments. These statements must be testable. Identification of Variables: Stating the factors or variables which affect the experiment. It is important to manipulate the variables being tested and keep all other variable constant. The one being manipulated is the independent variable. The one being measured is the dependent variable. Defining Variable Operationally: Operationally describe the variables of an experiment. Describing Relationship between Variable: Describe the relationship between variables in an experiment such as independent and dependent variables. Designing Investigation: Design an experiment in a systematic way to test a hypothesis. Experimenting: Carry out an experiment carefully by following correct procedure so that results can be verified by repeating the procedure several times. Collection of data: Collect qualitative and quantitative data during experiments through observations, measurements and any other means. Employ sensory organs to collect information. Recording the Data: record the quantitative and qualitative data for further use. Analysing Investigations: Interpreting data statistically, identifying human mistakes and experimental error, evaluating the hypothesis, deriving inferences, and design further investigation if necessary. Identifying the Cause and Effect Relationship: Identify the factor or variable which affect the experiment. During the process of doing science, scientist and students employ both Basic and integrated science process skills. By employing the process skills one can acquire the procedural of doing science and conceptual clarity Nature of Science. Process Skills domain has its own values and

identity in science. It is the most important domain wherein all other domains of science can be developed. Process skills are inventive and exciting activity to search the knowledge. These skills must be nurtured among the students in a systematic manner so that they become scientifically literate in their life. The nature of science process skills describes the systematic method of knowing science.

The nature of science process skills have certain characteristics, they are:

- It leads to the development of scientific concepts. Agreement and disagreements are the important features of process skills through which inference can be derived.
- Productive thinking can be encouraged in relation to the processes of science.
- Process skills follows empiricism many empiricists or scientist such as Fleming, Einstein, Newton, Galileo, and early Greek scientist Aristotle and Archimedes are used these skills during their inventions.
- Verification and generation of new concepts is one of the important natures of process skills.
- During Process skill sensory Organs associated with cognitive operation therefore it sharpens the thinking skills and these thinking skills are developmental in nature.
- Process skills develop scientific attitude, scientific temper and values.
- It helps to find out the relationship between cause and effect about a particular phenomenon.
- Intellectual abilities such as curiosity, creativity, problems solving, decision making are intertwined with nature of Process skills.
- Process skills connect with the persons to the physical and biological world.
- Process skills helps the learner to learn any complex concepts in science, also it facilitate the learner to learn other subjects.
- Accuracy and truthfulness.
- Abilities to formulate new ideas, concepts by their own.
- It removes misconception in science and it freedom from superstitious believe.

Science is a part of school Education and it act as a starting point for children intellectual and personal development results individual can prepare better life. Such teaching methods shouls be adopted so that school science should prepare the children to understand basic scientific concepts and process skills and its application. It should develop attitudes and values, also prepares the children to

study science in higher education. It was stated by reports and documents that one of the main objectives of science teaching is development of process skills Harlen (1999) stated that the process skills and content of science are inseparable, "Process skills must be taught in relation to some type of content". Curriculum for science education (NCERT, 1990; NCF, 2000; NCF, 2005) also emphasising the process skills. The present science education is far away from the above vision. Science is being taught in the schools as a body of established facts obtained by individuals using infallible methods. The present classroom practices emphasize on the product side of science rather than the method of acquiring the knowledge, which is the scientific method that forms the process side of science.

Thus, science teaching needs to be revised from teacher centeredness to student centred. Approach of teaching science to be broadened and it should facilitate the learner to be an active participant not a passive listener. Science Teaching should move away from rote learning. Teachers of science need to give ample scope for the students to expose the selves into hands on minds on experiences so that children can involve physically and intellectually in the learning process and acquire concepts and skills for their personal long term academic and personal success learning through one's own experience is more realistic, personal and meaningful. Activity based method is one such a method facilitates the students to participate actively in the learning process for acquiring knowledge and skills.

2.0.0 EMERGENCE AND JUSTIFICATION OF THE STUDY

Looking at the contemporary scenario of science education in schools, the issues and challenges are more with regard to instructional method, laboratory and equipments facilities, curriculum materials, and evaluation system of the above issues and challenges, instructional method plays a significant role in science education at any stage. Science teaching largely follows lecture method; occasionally demonstration was conducted in the classroom or laboratory. Science teaching was not emphasizing the process aspects. Science teaching was dominated by facts, concepts, principles, and generalization; teachers very rigidly following the experiments and investigations. It was recommended by Kothari Commission (1966) that there is a need of drastic change in teaching methods. Successively, Secondary Schools Science Teaching Projects (1969) conducted by NCERT collaboration with UNESCO pointed out that science education is not seen sufficiently as a whole

either from developing attitude, acquiring skills as well as gaining knowledge, and the topics studied and the methods employed are not sufficiently related to children natural interest, traditional attitudes towards learning science found in Indian Schools, investigatory method are not encouraged, rote learning is all common too. Nation struggling to achieve Universalisation of Elementary Education, UEE and Education for ALL, EFA, this is because one of the factors may be that low attract school for enrolment and drop out at the elementary stage due to lack of infrastructure facilities, untrained teachers in teaching (UNESCO, 1984). "The drop out problems in primary education Towards universalisation of primary Education in Asia and the pacific-Some case study".

A survey report by Indian Journal of Public Administration (1986) stated that most of the schools basic facilities for teaching learning process far from satisfactory level. 70 % middle schools had no laboratory facilities, and 41.5% had no blackboards. NPE (1986) also stated that the Present curriculum narrowly conceived, learning has become a rather mechanical process of acquiring skills and teaching has been largely a process of coaching for examinations and testing the memory, present syllabus emphasizing more on memorization and recall of information little or no progress was made in training the pupils in practical side of science.

Research findings (Veerappa, Ganguli and Vashista, 1991) revealed that the position of science teaching which was characterized by the "Herbatian" plane, lecture, lecture cum demonstration method and essay type examination (Fifth Educational Survey, 1988-92). Teaching is too mechanical very little or no active involvement by students in the process of learning; students are trained to blindly memories the content without thorough understanding of concepts. A survey conducted by PROBE (Public Report on Basic Education in India) on elementary education in the year 1996, findings reported that the following facilities such as blackboard, playground, drinking water, library, teaching kit are unavailable or available but not functional, similarly poor enrolment, inadequate teachers, lecture dominated teaching and rote learning, many of the classroom are not conducive for learning. Malhotra (1998) and Umasree (1999) study findings reveal that teachers often provide lecture and students are rarely given opportunity to do things or take initiatives largely, and students observe the teacher rather than actively participating in the classroom.

Teachers are not only transmitter of knowledge of science but also to engender in students a passion for science. Teachers of science have the challenging task of involving the students in scientific enterprises through science teaching. Student's science learning is low, because inadequate time to complete syllabus, lack of scientific equipment, inadequate physical infrastructure and lack of good teachers. Interest in science as well as satisfaction with the quality of science teaching declined as the age increased, all these issues may fail to express excitement towards science education. Aravind kumar the Director of Homi Bhabha Centre for Science Education stated that "it is unfortunate that the majority of the school across the country teach science in a boring and mechanical style allowing little room for original thinking and investigation. Most of the time, students spent on searching for correct answer; this is false interpretation of science teaching. Science is all about doing and learning even through mistakes (HBCSE, 2004).

The above observations are the evidence for poor transactional method employed by science teachers in most of the schools. Science is only subject having more scope to do experiment, investigation, demonstration, activity and discovery and so on but it is unfortunate that there is no innovation in teaching and assessment. Teachers are not providing opportunity for the students to do hands on-minds on experiences. Most of the time Teaching was going on in classroom; development of scientific skills, interests, attitudes, creative thinking, problem solving skills are remaining in an utter state of neglect. It is necessary to strengthen the quality of science teaching, rote memorization should be de-emphasized. There should be active involvement from student side, innovation and creativity to be promoted. Need a paradigm shift from "listening science" to "doing science". 96th Indian science congress also suggested that teaching of science needs to be refined substantially it must help the students to develop skills of procuring information and its analytical examination. Opportunity should be given for the students to carry out experimentation and investigation. Process skills should be nurtured in students. National Knowledge Commission (2006-09) recommended that all school children should be encouraged to involve in some practical activities that require working with hands. Teachers of science should not strictly follow only textbook and train the students to memories the concepts by ignoring the process skills. Content transmission is not the goal of science teaching. Basic content of science is important but those contents should be learned through process of science.

Process aspect of science is more important than the product. Process skills are fundamental for formulating scientific concepts; rediscover the new knowledge, to develop scientific attitudes, to promote logical and creative thinking, and curiosity. SAPA (Science: A Process Approach) describes that scientific process skills are defined as transferable skills that are applicable to many sciences that reflect the behavior of scientists. These curriculum reforms and projects stresses on process skills through different approaches such as inquiry approach, investigatory approach, and discovery approach of teaching science. All the Curriculum reforms and projects findings reveals that the process approach is more effective in increasing pupils' science achievement and attitude compared to traditional science program.

It was stated in the NCF (2005) that development of process skills up to standard X is one of the objectives of teaching of science. Till date several efforts have been made by researchers to study the effect of Activity Based Method on various variables in different disciplines and countries of the world. These researches shows that activity based method encourages learners to regain their interest, develop inquiry skills, critical thinking, creativity, problem solving, decision making skills etc. Some of the recent researches carried out in this field includes:

Zeidan & Jayosi (2015) investigated the relationship between the Palestinian secondary school students' knowledge level of science process skills and their attitudes toward science, and the effect of gender and residence of these students on their knowledge level of science process skills and on their attitudes toward science. Olufunke & Adebayo (2014) concluded that practical skills should be constantly developed in male as well as in female pupils so as to improve Basic Science practical skills of lower primary school pupils. Okere and Samuel W. Wachanga (2014) intended to compare the effect of science process skills teaching strategy (SPSTS) on boys' and girls' achievement in chemistry. Shah and Rahat (2014) observed that the activity based teaching was much effective than the lecture method of teaching science at elementary level. Mr. Ramesh M & Prof. R.C.Patel. (2014) investigated that they acquired process skills which helpful for later stage of education. In a nut shell, by observing the data triangulation, it can be said that the experiential learning intervention programme facilitates the students to acquire process skills. Mishra and Yadav (2013) concluded that Activity Based Approach is significantly effective than the traditional approach of teaching.

Mishra & Yadav (2013) reported that Activity Based Approach consisted of different activities for the all round development of children was significantly effective than the traditional approach of teaching.

Hariharan (2011) investigated the educational experiences and attainment of learning outcomes of students in class IV who have gone through the ABL methodology. Aktamis and Ergin (2008) observed that the scientific process skills education increased the students' achievements and scientific creativities; however, no meaningful progress was made on their attitude towards science. Further the levels of learning outcomes of public school students was found to be significantly lower than that of private school students even at basic levels of skills. Saat (2004) had conducted a study and examined the process of acquisition of integrated science process skills, particularly the skill of controlling variables, in a web based learning environment among grade five children. Data were gathered primarily from children's conversations and teacher revealed that the children acquired the skill in three phases: from the phase of recognition to the phase of familiarisation and finally to the phase of automation. Nevertheless the acquisition of the skill only involved the acquisition of certain sub skills of controlling variables. This progression could be influenced by the web based instructional material that provided declarative knowledge, concrete visualisation and opportunities for practice. . Hartikainen and Sorumunen (2003) observed that the quality of the pupils' procedural thinking concerning the scientific investigation is quite modest. Hesbon E.O. Abungu, Mark I.O. The results revealed that SPSTS made significant difference on achievement in chemistry between boys and girls. The results of the study indicated that there were significant differences in science process skills due to gender favoring females; and due to residence favouring villages' students. Lazarowitz and Huppert (1993) conducted an experimental study on "Science process skills of tenth grade biology students in a Computer Assisted Learning (CAL) setting." The results indicate that the experimental group performed significantly better on three science process skills a) graph communication b) interpreting data and c) controlling variables. The integration of CAL in to the existing Biology curriculum is discussed in the light of its potential to help students master science process skills and improve their academic achievement.

The above analysis of previous researches and their findings raises some research questions such as

1. Can the weakness of traditional method of imparting instruction be overcome by the activity based method?
2. How effectively science process skills can be developed among students by using activity based method?
3. What will be the effect of teaching science process skills through activity based method on the achievement of students?
4. What will be the effect of activity based method on attitude of students towards science.

As discussed earlier, in so many researches related to activity based method surveyed by the researcher so far it was found that no study has been conducted to study the "Effect of activity based method on science process skills, achievement and attitude of secondary level students". There is a lack of researches related to the activity based method for the improvement of science teaching and development of science process skills among secondary level students. So the researcher has decided to work on this topic which provides opportunity for pupils to work in co-operative manner, to develop original ideas making learning process in an entertaining manner.

3.0.0 STATEMENT OF THE PROBLEM

Effect of activity based method on science process skills, achievement and attitude on secondary level students

4.0.0 DEFINITION OF THE TERM USED IN THE STUDYS

4.1.0 Activity based method

Panko Kenley (2007) "students actively participate in the learning experience rather than sit as passive listeners".

Operational definition: This is a method of teaching where children learn through experience, observation and active participation.

4.2.0 Academic achievement

According to International Dictionary of Education (1978) "Academic achievement is performance of students in different subjects in a standardized series of educational test"

Operational definition: In this study the term Academic achievement involves performance of students in Science subject as indicated by their test scores.

4.3.0 Attitude

Eagly (1993) and (1995) stated that attitudes are learned predispositions to respond in the favorable or unfavorable manner to a particular person behavior belief or thing.

Operational definition: In this study "Attitude" refers the affinity towards the positive and negative sides of behavior related to Activity Based Method in Science subject.

4.4.0 Science Process skills

Screen (1996) define the Science Process Skills as the sequence of events that are engaged by researchers while taking part in scientific investigation they may be classified in to two types (1) Basic Science Process skill (2) Integrated Science Process Skill.

Operational definition: In the present research work Science Process Skills are those basic skills that students used to construct science concepts through Activity Based Method these basic skills are observing, classification, inferring , communication, measuring, scientific thinking, predicting.

5.0.0 OBJECTIVES

Objectives of the present study were as follows-

1. To conduct content analysis of class IX science text book.

2. To prepare lesson plans using Activity Based Method for teaching science process skills.

3. To study the effect of activity based method on development of Science Process Skills of IX class students.

4. To study the effect of Activity Based Method on academic achievement of IX class students.

5. To study Attitude of students towards science after teaching through Activity Based Method.

6.0.0 HYPOTHESES OF THE STUDY

In order to test the third objective of the study the following null hypothesis had been formulated

H_o1: There will be no significance difference in mean gain Science Process Skills scores of the students taught through Activity Based Method and traditional method.

H_o 2: There will be no significance difference in mean gain achievement scores of the students taught through Activity Based Method and traditional method.

H_o 3: There will be no significant difference in mean gain attitude scores of the students taught through Activity Based Method and traditional method.

7.0.0 Variables of the study

The independent variable: Activity Based method

Dependent variable: Achievement, Attitude, and Science Process Skills.

Extraneous variables:

These variables will be controlled as shown in the following table:

Category of Variables	**Variables**	**Controlling techniques used**	**Methods of controlling**
Sub ject related variables	Age SES	Sample selection	Through Randomization
	Anxiety Motivation	Rapport establishment	By Researcher
Environment related variables	Classroom climate	Rapport establishment	By Researcher
	Noise	Removed	Psychologically by researcher
	Light Test time Test administration	Constancy	By Researcher
Sequence related variables	Practice	Eliminated	Psychologically by researcher
	Fatigue	Eliminated	Psychologically by researcher
	Cooperation	Constancy	By Researcher

Table 1.1: Methods of controlling Extraneous variables

8.0.0 DELIMITATIONS OF THE STUDY

The study will be delimited in the following points

1. The study will be delimited to Agra city only
2. The study will be confined to secondary school of U.P. Board.
3. The study will be conducted on IX class students.
4. The study will be delimited to Science subject only.

9.0.0 METHOD OF THE STUDY

For the achievement of above mentioned objectives Experimental research method will be employed in the present study.

"Experimental method is the description and analysis of what will be or what will occur under controlled conditions". (Best, 1997).

10.0.0 SAMPLE OF THE STUDY

For this study IX class students of science group will be treated as sample and number of sample units for school students is 60. It will be divided into two equal groups, one group will be considered as Experimental group A and second and group will be considered as control Group B. 30 students each for experimental and control group will be selected from 9^{th} class. Selection of school will be decided according to the situations at the time of research.

The process of sample selection in the present research will be as follows:

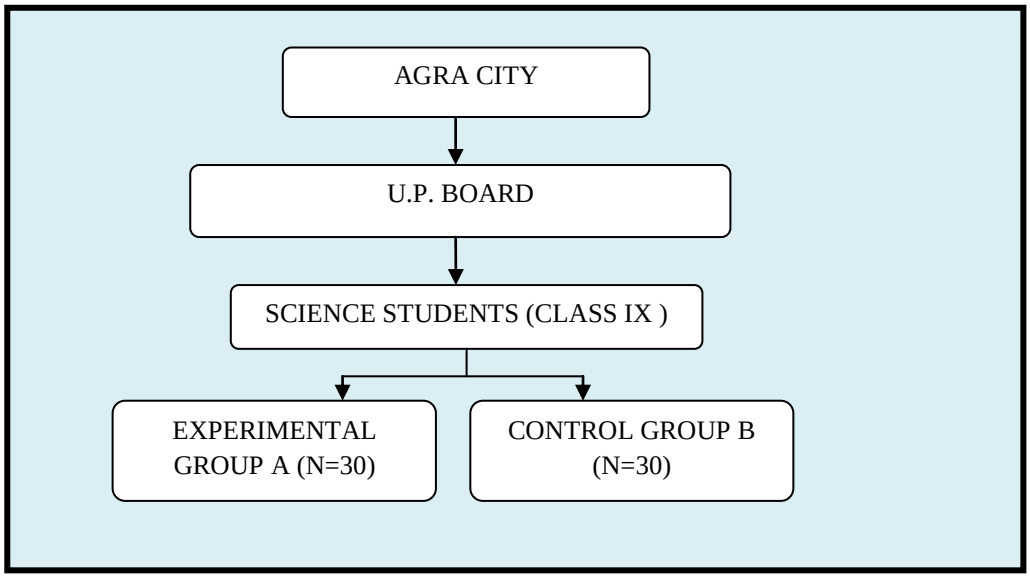

Figure 1.5: selection of the sample

11.0.0 PROCEDURE AND DESING OF THE STUDY

Present research work will be based on following procedure and design which are as follows:

11.1.0 Procedure of the study

Procedure of the present study will incorporate following steps:

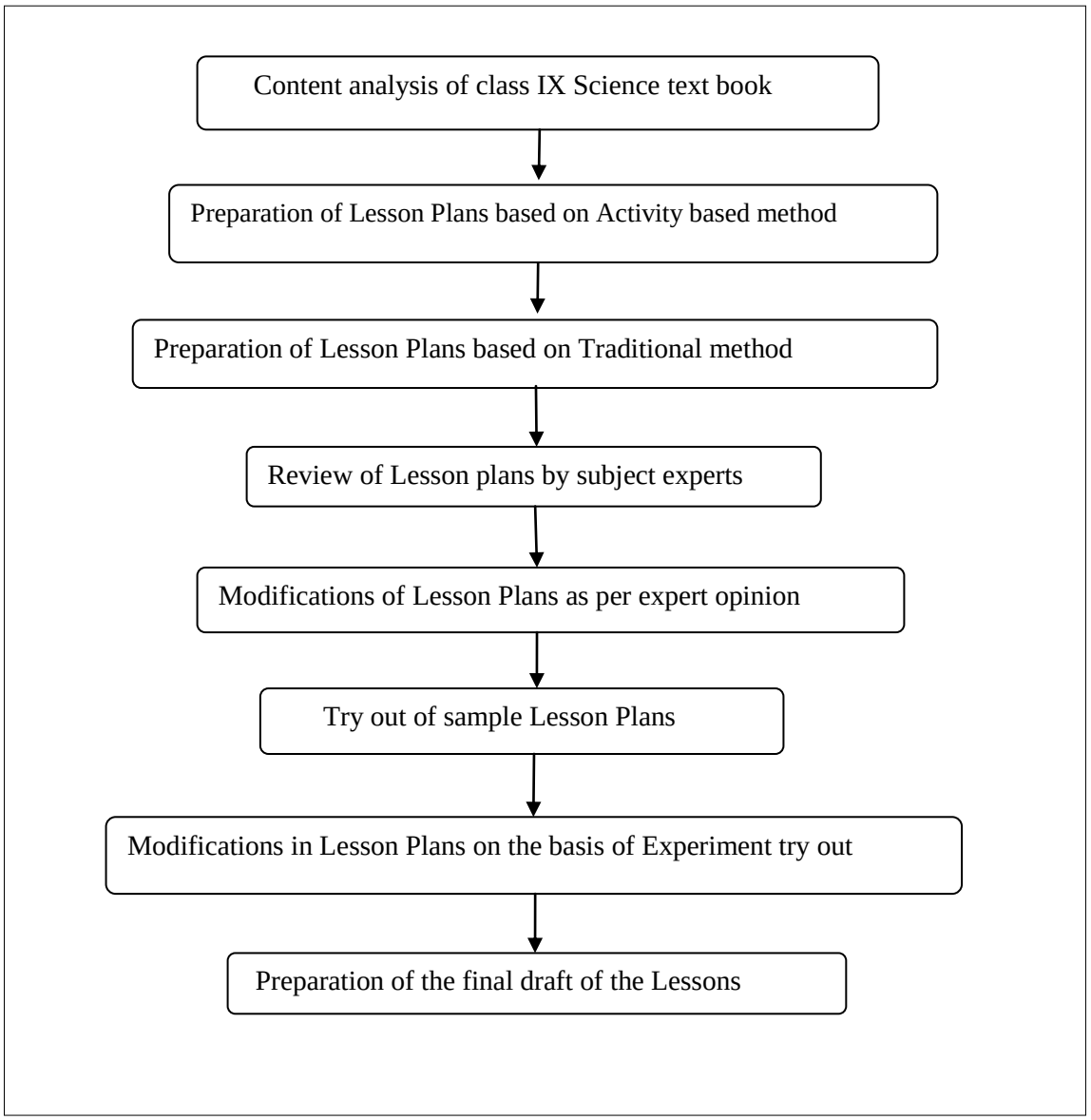
Content analysis of class IX Science text book
Preparation of Lesson Plans based on Activity based method
Preparation of Lesson Plans based on Traditional method
Review of Lesson plans by subject experts
Modifications of Lesson Plans as per expert opinion
Try out of sample Lesson Plans
Modifications in Lesson Plans on the basis of Experiment try out
Preparation of the final draft of the Lessons

Fig 1.6: Procedure of the study

11.2.0 Steps for developing Activity based lesson plans

The researcher will develop Lesson plans based on activity based method which will be based on following steps:

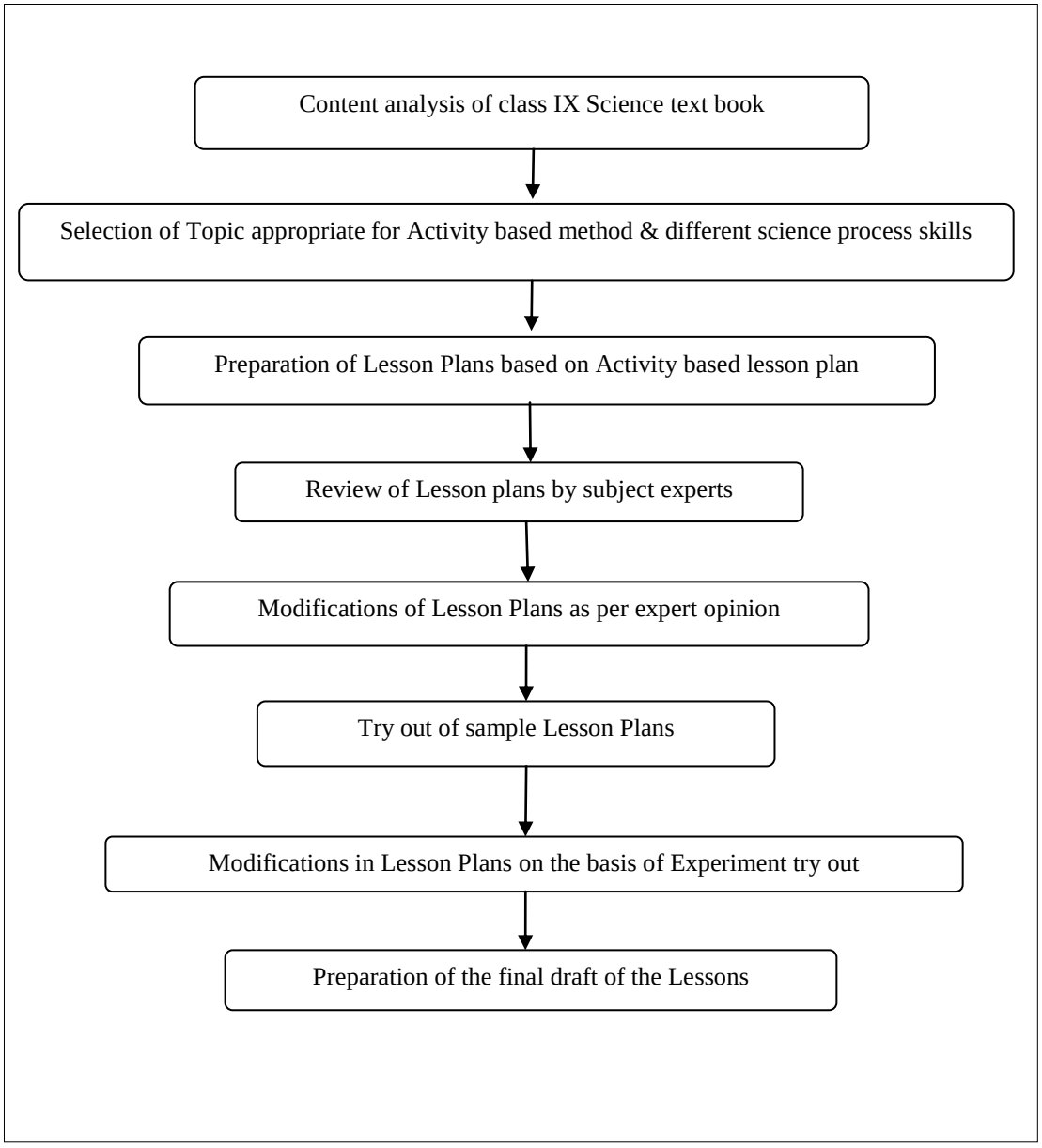
Content analysis of class IX Science text book
Selection of Topic appropriate for Activity based method & different science process skills
Preparation of Lesson Plans based on Activity based lesson plan
Review of Lesson plans by subject experts
Modifications of Lesson Plans as per expert opinion
Try out of sample Lesson Plans
Modifications in Lesson Plans on the basis of Experiment try out
Preparation of the final draft of the Lessons

Fig 1.7: Development of Activity based lesson plans

11.3.0 Research Design of the study

Two group pre-test post-test designs will be used in the present study which will be conducted in three phases

Phase-1: Planning phase

Phase-2: Implementation phase

Phase-3: Evaluation phase

<table>
<tr><th colspan="6">Phase I-Planning phase</th></tr>
<tr><th></th><th colspan="4">Phase II-Implementation phase</th><th>Phase III-Evaluation phase</th></tr>
<tr><th>Groups</th><th>Pre-test</th><th colspan="3">Treatment</th><th>Post-test</th></tr>
<tr><td rowspan="2">Experimental group</td><td rowspan="2">1-Science process skill test
2-Science achievement test
3-Science attitude scale</td><td>Sample</td><td>Treatment</td><td>Duration</td><td rowspan="2">1-Science process skill test
2-Science achievement test
3-Science attitude scale</td></tr>
<tr><td>(N=30) School students</td><td>Teaching science lesson using Activity based method</td><td>40 Periods (One period per day)</td></tr>
<tr><td>Control group</td><td>1-Science process skill test
2-Science achievement test
3-Science attitude scale</td><td>(N=30) School students</td><td>Teaching science lesson using Traditional method</td><td>40 Periods (One period per day)</td><td>1-Science process skill test
2-Science achievement test
3-Science attitude scale</td></tr>
</table>

12.0.0 TOOLS OF THE STUDY

20 lesson plans will be prepared by the researcher in traditional as well as Activity based method. Every Science lesson plan is planned for duration of 40 minutes from the U.P. Board curriculum of Science prescribed for class IX. In order to measure Science Process skills, Achievement and Attitude tools will be prepared.

1. Science Process Skills Test (SPST)

2. Science Achievement Test (SAT)

3. Science Attitude scale (SAS)

14.0.0 STATISTICAL TECHNIQUS

The data will be analyzed in light of objectives of the study both qualitatively as well as quantitatively. Certain Descriptive and Inferential statistics will be used in order to describe the nature and distribution of the scores obtained on various tests. This will include following methods analysis:

1. Mean: Mean value will be calculated for the distribution of attitude scores, achievement scores and Science process skills scores.

2. Standard Deviation: It will be calculated to study the variation in the scores.

3. t-test: Inferential Statistics techniques such as t-test will be employed for testing significance of the difference between the experimental and control group on the bases of pre-test, post-test scores.

15.0.0 SIGNIFICANCE OF THE STUDY

The result of the following study if found to be significant were help:

1. Students to actively participate in the learning process.
2. Along with active participation this method will help in improving their thinking capacity and achievement.
3. By doing activity students will be able to develop their science process skills as well as creative skills.
4. As activity based method follows principles of teaching it will prove to be beneficial for slow learners.
5. It will help students by allowing them to learn by their own pace.
6. This method of learning will help in making classroom environment alive. Along with this it was help in attracting student's attention.
7. This will help teachers in making their students learn about the basic concepts as teacher provides proper opportunity with instruction to perform different activities.
8. Student will get benefit as this method provides direct experiences to them because they will participate actively.

9. As senses are the gateways of knowledge. This method will be also help in providing training to sense organs. Learning will be more effective when various senses are involved in the process of learning.
10. It will make the learning experiences richer and more meaningful for students. They will learn the skills of science as well as science content.
11. The students will be actively engaged with the science they are learning and thus reach a deeper understanding of the content.
12. Finally active engagement with science process skills will lead students to become more interested and have more positive attitudes towards science.

REFERENCES

Abungu, H.E.O., Okere, M.I.O., & Samuel Wachanga, W. (2014). Effect of Science Process Skills Teaching Strategy on Boys' and Girls' Achievement in Chemistry in Nyando District, Kenya, 5, 15.

Aktamis, H., & Ergin, O. (2008). The effect of scientific process skills on students' scientific creativity, scientific attitude, and academic achievements. *Asia Pacific Forum on Science Learning and Teaching, 9,*1.

American Association for the Advancement of Science [AAAS] (1993). Benchmarks for science literacy. Retrieved from: *http://www.project2061.org/publications/ bsl/online/index.php.*

Bentley, M. L. & Ebert, E. S. (2007). *Teaching constructivist Science, Nurturing Natural Investigators in the Standards - Based Classroom.* Published by Corvin Press: A SAGE Publications Company: New Delhi, India

Best, J. W. & Kahn, J. V. (1993). *Research in Education. (7th Ed.).* New Delhi: Prentice Hall of India Private Ltd.

Conant, I .B. (1951). *Science and Common Sense.* New Haven, Conn: Yale University Press.

Conant, J.B. (1951). *Science and Commonsense*. New Haven: Yale University Press.

Eagly, A.H., & Chaiken, S. (1993). *The psychology of attitude*. For Worth, TX: Harcourt Brace Jovanovich. Fitzpatrick, F. (1960). *Policies for Science Education*. Columbia University, New York.

Fitzpatrick, F.C. (1960). *Policies for science Education.* New York: Bureau of Publications.

Galyam, N., and Grange, L.L. (2003). Teaching Thinking Skills in Science to learners with special needs. *International Journal of Special Education, 18, 2, 27-29.*

Government of India (1952-53). Report of Secondary Education Commission. New Delhi: Ministry of Education & Youth services.

Government of India. (1966). Report of Education Commission Resolution. New Delhi: Ministry of Education Government of India.

Griggs, C. (1990). *Science in the primary School Curriculum, Bulletin No.2*. The School Master Published Company Ltd, London.

Guilford (1978). *Psychometric Methods*. New York: Mc Graw-Hill Publishers.

Harfield,T., Davies, K., Hede, J., Panko, M. & Kenley,R. (2007). Activity based teaching for Unitec Newzealand Construction students. *Emirates Journal of Engineering Research, 12(1)*, 57-63.

Hariharan, P. (2011). Effectiveness of activity – based – learning methodology for elementary school education. Paper Submitted for National Child Rights Research Fellowship 2010. Retrieved from: http://www.cry.org/

Harlen, W. (1992). *UNESCO source book for science in the Primary School:* A workshop approach to teacher education: National Book Trust in association with UNESCO. New Delhi, India.

Harlen, W. (1999). Purposes and Procedures for Assessing Science Process Skills. *Assessment in Education: Principles, Policy & Practice*, 6(1), 129-144.

Hurd, P.D. (1971). *New directions in teaching secondary school science*. Chicago: Rand Mc Naly and Co. Jadal, M. M. (2012). Use of activity based joyful learning approach in teaching environmental science subject at primary level. *Academic Journal*, 2 (7) 1.

Joseph, C. (1998). Study on process outcomes in physics in relation to some select cognitive, affective, social and environmental variables. An published Doctoral thesis in Education. Mahatma Gandhi University Kottayam, Kerala. Retrieved from: *http://www.mgutheses.in*.

Kuhn Thomas (1970). *The Structure of Scientific Revolutions*. Chicago, University of Chicago.

Lazarowitz, R., and Huppert, J. (1993). Science process skills of Tenth Grade biology students in a computer assisted learning setting. *Journal of Research on Computing in Education, 4(2),367*.

Levin, M.J. (1978). *Psychology: A biographical approach.* New York*:* Mc Graw Hill.

Menon, S.B. (1986). System of science and the perspective of the process of science inquiry. An unpublished Doctoral thesis in Education, The Maharaja Sayajirao university of Baroda, Vadodara. In M.B. Buch (Ed.). *Fourth Survey of Research in Education, NCERT.*

Mishra, S. K. & Yadav B. (2013). Effect of activity based approach on achievement in science of students at Elementary stage. *International journal of basic and applied science*. *1,716 – 733*.

Monhardit , L., & Monhardit, R. (2007). Creating a context for the learning and science process skills through picture books. *Early Childhood Education, 34(1),* 67-71.

National curriculum Framework (2005). National Council of Educational Research and Training. Delhi.

National Knowledge Commission. (2006-09). *Report of the Nation:* Published by National Knowledge Commission, Government of India: New Delhi, India.

National Policy on Education. (1986). Programme of Action (1992). Department of Education, Ministry of Human Resource Development. Government of India: New Delhi, India.

National Research Council. (1996). *National Science Education Standards: Observe, interact, change, and learn*. National Committee on Science Education Standards and Assessment. Washington, D.C: National Academy Press.

National Science Teachers Association. (2002). *NSTA Position Statement: Elementary school science*. Retrieved from: National Science Teachers Association website: http://www.nsta.org/about/positions/elementary.aspx.

NCERT (1964-66). Report of Education Commission. Education and National Development New Delhi: India.

NCERT (2000). National Curriculum Frame Work. New Delhi.

Olufunke & Adebayo, F. (2014). Effect of Gender on Basic Science Practical Skills of Lower Primary School Pupils. *Journal of emerging trends in Educational Research and Policy Studies 5(6)*: 679-683.

Onwueqbuzie, A.J. (2000). Science process skills and Achievement in Research Methodology courses. Paper presented at the Annual meeting of the Mid South Educational Research Association, 15 Nov. 2000. http://eric.ed.gov/Eric Web portal/record Detail.

Pai, B.D. & Rao, M. P. (2007). To study the effectiveness of instructional package in science teaching competencies over teachers' performance and their impact over students' achievement and process skills in science. An published Doctoral thesis *in education*. Regional Institute of Education (NCERT) Mysore.

Ramadas, J. & Chunawala, S. (2006). Research Trends in Science, Technology and Mathematics Education. *Review talks delivered at episteme -1 an international conference to review research on science, Technology and Mathematics Education*. Published by HBCSE and Tata Institute of Fundamental Research Mumbai, India.

Ramesh & Patel,R.C..(2014). Acquisition of science process skills through experiential learning in students of standard viii. An published Doctoral thesis *in education. The M. S. University of Baroda, Vadodara.*

Saat, R.M. (2004). The acquisition of Integrated Science Process Skill in a web based learning Environment. *Research in Science and Technological Education, 22(1),* 23-40. Schlessinger, C. (2000). Teaching of Science. Ludhiana: Tandon Publication.

Shah, I. & Rahat, T. (2014). Effect of activity based teaching method in science. *International Journal of Humanities and Management Science*,2, 39-41.

Temiz, B.K., Taser, M.F., & Tan M. (2006). Development and Validation of a Multiple format Test of Science process skills. *International Education Journal , 7(7)* , 1007-1027.

The PROBE Team. (1998). Public Report on Basic Education in India.

UNESCO. (1984). *The drop out problems in primary education Towards Universalisation of primary Education in Asia and the Pacific–Some case study:* UNESCO Regional Office for Education in Asia. Bangkok.

UNESCO. (1992). *Towards Developing New Teacher competencies in Response to Mega Trends in Curriculum Reforms.* A Report of a regional study Group Meeting on Teacher Education organised by UNESCO PROAP in Collaboration with the department of Teacher Education. UNESCO Principal Regional Office for Asia and the Pacific, Bangkok.

Victor, E. and Lerner, MS. (1971). Readings in Science Education for flit' Elementary,, School (2nd Edition) New York: The Macmillan Company.

Yadav & Mishra (2013). A Study of the Impact of Laboratory Approach on Achievement and Process Skills in Science among Is Standard Students. International Journal of Scientific and Research Publications, 3, (1),1-6.

Zeidan, & Jayosi. (2015). Science Process Skills and Attitudes toward Science among Palestinian Secondary School Students. *World Journal of Education, 5, (1),* 13-24.